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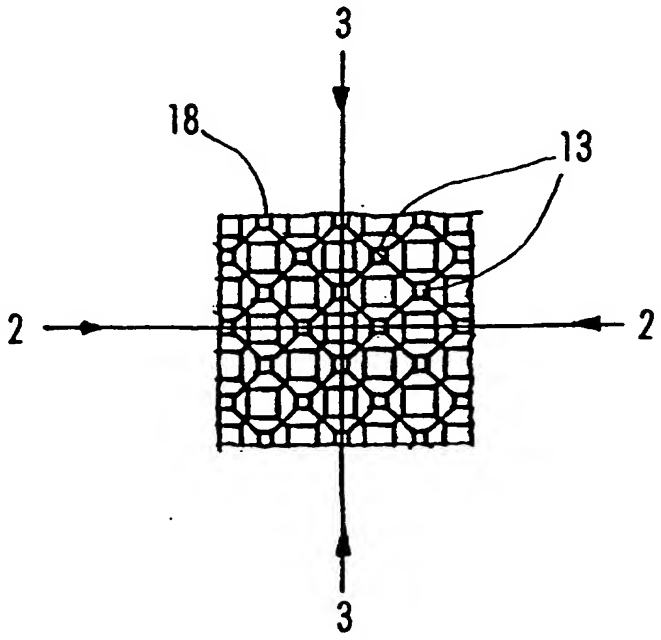
(54) Title: THIN MULTI-PLY CELLULAR PLATE WITH GOOD DRAWABILITY AND PROCESS FOR THE PRODUCTION THEREOF

(57) Abstract

A thin multi-ply cellular plate (18) with good drawability for products of mass-production manufacturing comprises a couple of external sheets or films essentially parallel to and spaced apart from each other, and an internal cellular structure fixed to and between said external sheets or films defining substantially a plane; said internal cellular structure comprises either a single compact diamond-embossed sheet or film, having a multiplicity of small scale tridimensional relieves and depressions (13) distributed with uniform pitch p in substantially mutually perpendicular directions in the plane, or a plurality of said compact diamond-embossed sheets or films, with or without interleaved intermediate flat sheets, superposed one upon the other and made integral in rigid and permanent manner.



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TITLE

"THIN MULTI-PLY CELLULAR PLATE WITH GOOD DRAWABILITY AND PROCESS FOR THE PRODUCTION THEREOF "

TEXT OF THE DESCRIPTION

Field of the invention - The present invention relates to a thin multi-ply cellular plate with good drawability for products of mass-production manufacturing and to a process for the production thereof.

Related Technological Art - It is widely known that, for example, cellular metallic sheet answers the requirement of offering much greater mechanical resistance to bending/torsional stress than compact metallic sheet of equal weight; cellular metallic sheets are known, wherein the cells are produced using numerous elements suitably spaced apart or using the honeycomb technique. The cellular metallic sheet produced up to the present has a cost per reference unit, for example per square metre, that is high, with the result that use thereof has been limited to special, not widespread applications.

Similarly, synthetic thermoplastic resin cellular panels obtained from the extrusion process are known, wherein the cellular structure consists of a series of thin vertical elements spaced a certain distance apart and connected to the two external flat films, the whole constituting a complete cellular plate. These known types of thermoplastic resin cellular plates, by the shape of their cellular structure, offer a resistance to bending/torsional stress and to bending action that varies considerably depending on whether the stress or action is parallel or perpendicular to the vertical elements comprising the cells; such an irregular pattern of behaviour poses a set of limitations and problems regarding usage of semifinished items of these types in the production of packs and wrappings for packaging or of binders and folders for the stationery goods sector.

Summary of the invention - One object of the present invention is therefore to define a thin multi-ply cellular plate with good drawability for products of mass-production manufacturing, wherein it comprises an internal cellular structure consisting of a single compact sheet or film of a material (e.g. a metal, a metal alloy or a synthetic thermoplastic resin) of suitable characteristics, diamond-embossed to give a substantially 'hills' and 'valleys' type profile in which small, uniform type cells are created; and a couple of external sheets or films, of the same or of a different material than the internal sheet.

These cells are of dimensions, shape and distance apart that are consistent with resistance to the bending/torsional stress whereto the cellular structure is subjected when rigidly and permanently coupled with the couple of flat, external sheets or films, so as to constitute a whole thin multi-ply cellular plate.

Another object of the invention is to define a thin multi-ply cellular plate with good drawability for products of mass-production manufacturing comprising a first external sheet or film and a second external sheet or film essentially parallel to and spaced apart from each other; and an internal cellular structure fixed to and between said first external sheet or film and said second external sheet or film defining substantially a plane, characterized in that said internal cellular structure comprises either a single compact diamond-embossed sheet or film, having a multiplicity of small scale tridimensional relieves and depressions distribuited with uniform pitch p in substantially mutually perpendicular directions in said plane, or a plurality of said compact diamond-embossed sheets or films, superposed one upon the other and made integral in rigid and permanent manner.

There are greatly enhanced possibilities of using the plate defined above as semifinished products in the vast number of different industrial sectors; just to mention one, a multi-ply cellular plate having metallic internal and external sheets can withstand the deep-drawing process widely used especially in the automotive industry for car body

manufacturing, combining the advantageous features of known cellular sheets in terms of mechanical resistance to bending/torsional stress, with the low cost of standard compact sheets.

Another object of the invention is to define a continuous automated manufacturing process, with particular industrial and economic value, for the production, as semifinished products, of a thin multi-ply cellular plate with good drawability drawability for products of mass-production manufacturing, wherein it comprises an internal cellular structure consisting of a single compact sheet or film of a deformable material of suitable characteristics diamond-embossed; and a couple of flat, external sheets or films permanently coupled with the internal cellular structure.

The above objects are achieved by means of a thin multi-ply cellular plate with good drawability for products of mass-production manufacturing, and of a process for the production thereof, according to the main claims.

These and other objects, characteristics and advantages of the present invention will become apparent in the course of the following description of preferred embodiments, provided as a non-exhaustive examples, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 represents a plan view in an arbitrary scale of a part of the internal cellular structure of the thin multi-ply cellular plate according to the invention.

Fig. 2 is a cross-sectional view in an arbitrary scale of the internal cellular structure of Fig. 1 along a line 2-2.

Fig. 3 is a cross-sectional view in an arbitrary scale of the internal cellular structure of Fig. 1 along a line 3-3, perpendicular to the line 2-2.

Fig. 4 represents in an arbitrary scale a cross-sectional view of the complete thin multi-ply cellular plate with a single-layer internal cellular structure according to a first embodiment of the invention.

Fig. 5 represents in an arbitrary scale a cross-sectional view of the complete thin multi-ply cellular plate with a two-layer internal cellular structure according to a second embodiment of the invention.

Fig. 6 represents in an arbitrary scale a cross-sectional view of the two-layer internal cellular structure of thin multi-ply cellular plate of Fig. 5.

Fig. 7 represents in an arbitrary scale a cross-sectional view of the complete thin multi-ply cellular plate according to a third embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A cross-sectional view of a first embodiment of the thin multi-ply cellular plate of the invention is represented in Fig. 4, in which a three-ply cellular plate 10 is composed by a first external sheet or film 16 and a second external sheet or film 17, essentially parallel to and spaced apart from each other; and an internal single-layer cellular structure 15, fixed to and between the first external sheet 16 and the second external sheet 17, defining substantially a plane and consisting of a single compact sheet or film 18 (Fig. 1) showing a diamond-embossed profile having a multiplicity of small scale tridimensional relieves (or 'hills') and depressions (or 'valleys'), forming in combination a multiplicity of cells 13, distribuited with a uniform pitch p in substantially mutually perpendicular directions in the plane.

The materials of which the sheets 16, 17 and 18 are made can be a metal sheet (as non-limiting examples a steel sheet, a stainless steel sheet, an aluminium sheet, an aluminium alloys sheet, a titanium sheet, a titanium alloys sheet, a copper sheet, or a copper alloys sheet) or a synthetic thermoplastic resin sheet or film (as non-limiting examples a polypropylene sheet or film, a polyethylene sheet or film, a polyvinyl sheet or film, a polyamide sheet or film, a polycarbonate sheet or film or a

polystyrene sheet or film); it is intended that the sheets 16, 17 and 18 can be made all of the same material, or only partly or totally of different materials. As a non-limiting examples, the first external sheet 16 and the second external sheet 17 can be made of steel and the compact diamond-embossed sheet 18 can be made of synthetic thermoplastic resin film; or, viceversa, the first external film 16 and the second external film 17 can be made of synthetic thermoplastic resin film and the compact diamond-embossed sheet 18 can be made of steel..

A detailed description of the thin three-ply cellular plate 10 of the invention will now be described with reference to a case in which all the three sheets 16, 17 and 18 are made of steel.

The sheet of steel from which the compact diamond-embossed sheet 18 is made has a thickness t_i, whose preferred values range from 0,05 to 2 mm, best from 0,1 to 1 mm. The plan section shape of the single cell 13 can be circular or polygonal, in particular can be substantially squared as shown in Fig. 1 as illustrative example; the embossing creates a tridimensional impression, having sharp or rounded edges, of a total height h (Figs. 2 and 3), whose preferred values range from 0,1 to 5 mm, best from 0,5 to 3 mm.

In order to obtain the best result, preferred values higher than or equal to 1 of the ratio p/h of the pitch p and the height h are employed, a value p/h substantially equal to 2 being the best value; the first external metal sheet 16 and the second external metal sheet 17 have corresponding thicknesses t_1 and t_2 whose values are preferably higher than t_i.

The small uniform nature of the cells 13 permits a very high number, preferably as high as approximately 100 per square centimeter, of fixing bridges between the first external sheet 16 or the second external sheet 17 and the compact diamond-embossed sheet 18, giving the thin three-ply cellular plate 10 a high mechanical resistance to compression and the possibility to withstand a deep-drawing processing.

Now a process for continuous automatic production of the foregoing three-ply metallic cellular plate 10 is described.

The process comprises a first and a second step; the first step consists in the production of the compact diamond-embossed sheet 18, by impressing on a single compact sheet of steel the bidirectional pattern of the multiplicity of small scale tridimensional relieves and depressions forming in combination the multiplicity of cells 13 shown in Fig. 1, distribuited with the uniform pitch p both longitudinally and transversally across the plane; the impression is done by conveying the sheet of steel into the nip between a couple of forming rolls in an automatic roll forming machine of conventional design.

The second step of the process consists in coupling in rigid and permanent manner the first external metal sheet 16 and the second external metal sheet 17 to the compact diamond-embossed sheet 18, by projection resistance welding the latter between the first external metal sheet 16 and the second external metal sheet 17 in a continuous electric welding machine of conventional design.

Naturally variants, additions or changes may be made to the foregoing process by persons skilled in the sector art.

For example, it is possible to use a cold plastic deformation process, or a coining process, or a hot plastic deformation process, or an embossing process, or a hot roll-forming process for the production of the compact diamond-embossed sheet 18; or it is also possible to use a coupling process for joining the first external metal sheet 16 and the second external metal sheet 17 to the compact diamond-embossed sheet 18 of the type of electric welding, or laser welding, or spot welding, or ultrasonic welding, or hot pressure welding, or diffusion bonding, or soldering, or brazing, or press bonding, or adhesive bonding.

It is also possible to additionally introduce in the foregoing process a third step consisting in surface coating before coupling the sheets 16, 17 and 18 (all of them, or only part of them), with a suitable material (for example a metal alloy or a deoxidising film) in order to improve the

coupling process itself. A further fourth step can be introduced in the foregoing process, in addition or as a replacement of the third step, particularly when plain steel sheets are employed, consisting in surface coating before coupling the sheets 16, 17 and 18 (all of them, or only part of them), with an anti-oxidant or anti-corrosive material (zinc, for example).

A description of the thin three-ply cellular plate 10 of the invention will now be made with reference to a case in which all the three sheets 16, 17 and 18 are made of synthetic thermoplastic resin.

The criss-crossing 'hills' and 'valleys' of the diamond-embossing profile of the compact diamond-embossed sheet 18 (Fig. 1) are obtained, as a non-limiting example, by hot roll forming an extruded or laminated sheet or film made of a synthetic thermoplastic resin; the cells 13 are suitably spaced apart and are so shaped as to enable the compact diamond-embossed sheet or film 18 be joined permanently to the two external, synthetic resin sheet or films 16, 17 of suitable thickness and characteristics in order to form the complete cellular plate 10 of synthetic resin. Depending on the thermal and chemical properties of the synthetic resins being joined, numerous conventional industrial processes may be used for permanently joining the internal cellular structure 15 and the external synthetic resin sheets or films 16, 17 as, for example, thermal pressure welding, ultrasonic welding, or binding with strong adhesives, whether twin-component or not.

A cross-sectional view of a second embodiment of the thin multi-ply cellular plate of the invention is represented in Fig. 5, in which a four-ply cellular plate 20 is composed by the first external sheet or film 16 and the second external sheet or film 17, essentially parallel to and spaced apart from each other; and an internal dual-layer cellular structure 14 (Fig. 6), fixed to and between the first external sheet 16 and the second external sheet 17, defining substantially a plane and consisting of a couple of the compact diamond-embossed sheet or film 18 (Fig. 1), showing a diamond-embossed profile having a multiplicity of small scale tridimensional

relieves (or 'hills') and depressions (or 'valleys'), forming in combination a multiplicity of cells 13, distribuited with a uniform pitch p in substantially mutually perpendicular directions in the plane.

The two compact diamond-embossed sheets or films 18 constituing the internal dual-layer cellular structure 14 are superposed and made integral in rigid and permanent manner using a conventional coupling process, for example of the type of electric welding, or laser welding, or spot welding, or ultrasonic welding, or hot pressure welding, or diffusion bonding, or soldering, or brazing, or press bonding, or adhesive bonding.

A cross-sectional view of a third embodiment of the thin multi-ply cellular plate of the invention is represented in Fig. 7, in which a five-ply cellular plate 30 is composed by the first external sheet or film 16 and the second external sheet or film 17, essentially parallel to and spaced apart from each other; and an internal triple-layer cellular structure, fixed to and between the first external plate 16 and the second external plate 17, defining substantially a plane and consisting of a couple of the compact diamond-embossed sheet 18 (Fig. 1), showing a diamond-embossed profile having a multiplicity of small scale tridimensional relieves and depressions, forming in combination a multiplicity of cells 13, distribuited with the uniform pitch p in substantially mutually perpendicular directions in the plane, and an intermediate flat sheet 19 inserted between the couple of the compact diamond-embossed sheets 18 and made integral with them in permanent manner by using a conventional coupling process of the type listed before. With this configuration, a respective alignement of the tridimensional relieves and depressions of the two compact diamond-embossed sheets 18 during the coupling process is not required, but advantageously they can be randomly positioned.

In accordance with the present invention, it has been discovered that considerable improvements is obtained with the foregoing, enabling numerous competitive advantages to be obtained with respect to the existing solutions, and notably, in view of the lower production costs of the

semifinished product, its lower weight and improved thermal and acoustic insulation.

The possibility of application of the foregoing thin multi-ply cellular metallic plate on mass-production products, such as the chassis and bodywork of automobiles, household electrical products, panels for the building trade, etc., using the technologies already tried and tested with compact metallic sheet for transforming semifinished products into finished components, combined with the possibility of constructing diamond-embossed metallic sheet semifinished products from continuous, automated manufacturing processes endow the invention with particular industrial and economic value.

Also the advantages offered by the synthetic resin thin multi-ply cellular plate of this invention are numerous. The substantially uniform resistance to bending/torsional stress and to bending through the entire plane of 360° enables bends to be made along any direction whatsoever so that shapes and solutions are possible for the packs, wrappings and objects made from this semifinished product that are completely different from those made up to now with extruded thermoplastic cellular panel.

Furthermore, in view of the small, uniform nature of the cells, the synthetic resin thin multi-ply cellular plate of this invention may be hot-deformed using the vacuum molding technologies, enabling the products made from these semifinished products to assume curvilinear, three-dimensional shapes of any kind, especially useful, for example, in the packaging sector.

In addition, construction of the synthetic resin cellular thin multi-ply cellular plate of this invention employing sandwich technology to make the semifinished piece eliminates the 'mono' limitations associated with the material, the colour and finish of the extruded thermoplastic material, granting a practically unlimited range of aesthetic and functional variability of the outer synthetic resin films while maintaining a constant inner cellular structure.

The special shape assumed by the cellular structure in the synthetic resin cellular thin multi-ply cellular plate of this invention, with a double configuration of finely spaced 'hills' and 'valleys', means that low thickness, resistant, plate with internal single-layer, two-layer or multi-layer cellular structure can be obtained, as illustrated in Figs. 4, 5 and 7 representing a section thereof.

Thin multi-ply cellular plate according to the invention may also be built with one or both external thin films 16, 17 in a synthetic resin compatible with foodstuffs and therefore suitable for use in packaging of loose food products; it should also be remembered that the sandwich technique permits hybrid type, thin multi-ply cellular plates to be built wherein one or both of the external thin films 16, 17 are not of synthetic resin but, for example, of paper or combinations of paper with polyethylene or aluminium films.

From the foregoing, it will be apparent that there are greatly enhanced possibilities of using semifinished products of this type in the vast sector of packaging, with frozen foods for example, on account of the excellent thermal insulation properties of the semifinished products.

Naturally variants, additions or changes may be made to the present invention by persons skilled in the sector art.

For example, it is possible to use an internal cellular structure, made by more than two compact diamond-embossed sheets or films 18 coupled with the two external sheets or films,16, 17 flat in shape and constructed of a suitable material, the whole made integral by using any suitable conventional industrial process such as, for example, resistance projection welding, or laser welding, or brazing, or spot welding, or soldering, or press bonding, or strong bonding processe to produce the complete thin multi-ply cellular plate.

In short, while adhering to the principle of this invention, details of the design and the forms of embodiment described and illustrated in the foregoing may be amply modified without exiting from the scope of the invention.

CLAIMS

1. A thin multi-ply cellular plate with good drawability comprising:

- a first external sheet or film and a second external sheet or film essentially parallel to and spaced apart from each other; and
- an internal cellular structure fixed to and between said first external sheet or film and said second external sheet or film defining substantially a plane,

characterized in that said internal cellular structure comprises a compact diamond-embossed sheet or film having a multiplicity of small scale tridimensional relieves and depressions distribuited with uniform pitch p in substantially mutually perpendicular directions in said plane.

2. Cellular plate according to claim 1, characterized in that said internal cellular structure comprises a plurality of said compact diamond-embossed sheet or film, superposed one upon the other and made integral in rigid and permanent manner.

3. Cellular plate according to claim 1, characterized in that said internal cellular structure comprises a couple of said compact diamond-embossed sheet or film, and an intermediate flat sheet or film inserted between said couple of said compact diamond-embossed sheets, superposed one upon the others and made integral in rigid and permanent manner.

4. Cellular plate according to claim 1, 2 or 3, in which said small scale tridimensional relieves and depressions have a total height h, characterized in that said total height h has a value of between 0,1 and 5 mm.

5. Cellular plate according to claim 4, characterized in that said total height h has a value of between 0,5 and 3 mm.

6. Cellular plate according to claim 4, characterized in that the ratio p/h of said pitch p and said total height h has a value equal or higher than 1.

7. Cellular plate according to claim 6, characterized in that said ratio p/h of said pitch p and said total height h has a value approximately equal

to 2.

8. Cellular plate according to claim 1, 2 or 3, in which said compact diamond-embossed sheet or film has a thickness t_i, characterized in that said thickness t_i has a value of between 0,05 and 2 mm.

9. Cellular plate according to claim 8, characterized in that said thickness t_i has a value of between 0,1 and 1 mm.

10. Cellular plate according to claim 8, in which said first external sheet has a first thickness t_1 and said second external sheet has a second thickness t_2, characterized in that said first thickness t_1 and said second thickness t_2 are higher than said thickness t_i.

11. Cellular plate according to claim 1, 2 or 3, characterized in that said uniform pitch p is less than 1 mm wide.

12. Cellular plate according to claim 1, 2 or 3, characterized in that at least one of said first external sheet, said second external sheet, said intermediate sheet and said compact diamond-embossed sheet or film is made of metal.

13. Cellular plate according to claim 12, characterized in that said metal is selected from the group consisting of steel, stainless steel, titanium, titanium alloys, copper, copper alloys, aluminium and aluminium alloys.

14. Cellular plate according to claim 1, 2 or 3, characterized in that said first external sheet and said second external sheet are made of a material selected from the group consisting of paper, cellulose derivatives, polyethylene film coated paper, aluminium film coated paper and polypropylene film coated paper.

15. Cellular plate according to claim 1, 2 or 3 characterized in that at least one of said first external sheet, said second external sheet, said intermediate sheet and said compact diamond-embossed sheet or film is made of resin.

16. Cellular plate according to claim 15, characterized in that said resin is a synthetic thermoplastic resin selected from the group consisting of

polyamide resins, polyethylene resins, polypropylene resins, polystyrene resins, polycarbonate resins and polyvinyl resins.

17. Cellular plate according to claim 1, 2 or 3, characterized in that said multiplicity of small scale tridimensional relieves and depressions is obtained by means of a process selected from the group consisting of cold plastic deformation, coining, hot plastic deformation, embossing, continuous roll forming and vacuum hot molding.

18. Cellular plate according to claim 1, 2 or 3, characterized in that said internal cellular structure is fixed by means of a fixing process selected from the group consisting of electric welding, projection resistance welding, laser welding, ultrasonic welding, hot pressure welding, diffusion bonding, soldering, brazing and adhesive bonding.

19. Cellular plate according to claim 18, characterized in that said fixing process is continuous and automated.

20. Cellular plate according to claim 18, characterized in that at least one of said first external sheet or film, said second external sheet or film, said intermediate sheet or film and said compact diamond-embossed sheet or film has a surface coating of a coating material, whereby said fixing process is optimized.

21. Cellular plate according to claim 20, characterized in that said coating material is selected from the group consisting of a metal alloy and a deoxidising film.

22. Cellular plate according to claim 18, characterized in that at least one of said first external sheet or film, said second external sheet or film, said intermediate sheet or film and said compact diamond-embossed sheet or film has a surface coating of an anti-oxidant or anti-corrosion material.

23. A process for the production of a thin multi-ply cellular plate with good drawability, said plate comprising a first external sheet or film and a second external sheet or film essentially parallel to and spaced apart from each other; and an internal cellular structure fixed to and between said first external sheet or film and said second external sheet or film defining

substantially a plane, said internal cellular structure comprising a compact diamond-embossed sheet or film, characterized in that it comprises:

- forming said compact diamond-embossed sheet, by impressing a bidirectional pattern of a multiplicity of small scale tridimensional relieves and depressions forming in combination a multiplicity of cells, distribuited with a uniform pitch p both longitudinally and transversally across said plane; and

- coupling in rigid and permanent manner said first external sheet and said second external sheet to said compact diamond-embossed sheet.

24. A process according to claim 23, characterized in that it further comprises:

- surface coating at least one of said first external sheet or film, said second external sheet or film and said compact diamond-embossed sheet or film with a coating material, whereby said coupling in rigid and permanent manner said first external sheet and said second external sheet to said compact diamond-embossed sheet is improved.

25. A process according to claim 24, characterized in that said coating material is selected from the group consisting of a metal alloy and a deoxidising film.

26. A process according to claim 23, characterized in that it further comprises:

- surface coating at least one of said first external sheet or film, said second external sheet or film and said compact diamond-embossed sheet or film with an anti-oxidant or anti-corrosive material.

27. A process according to claim 23, 24 or 26, characterized in that said impressing said bidirectional pattern is done by conveying a single compact sheet of metal into a nip between a couple of forming rolls in an automatic continuous roll forming machine.

28. A process according to claim 23, 24 or 26, characterized in that said forming said compact diamond-embossed sheet is done by impressing said bidirectional pattern on a single compact sheet of metal

with a process selected from the group consisting of cold plastic deformation, coining, hot plastic deformation, hot roll-forming and embossing.

29. A process according to claim 23, 24 or 26, characterized in that said forming said compact diamond-embossed sheet is done by impressing said bidirectional pattern by hot roll forming a single compact extruded or laminated sheet or film of synthetic thermoplastic resin.

30. A process according to claim 23, 24 or 26, characterized in that said forming said compact diamond-embossed sheet is done by impressing said bidirectional pattern on a single compact sheet or film of synthetic thermoplastic resin by vacuum molding.

31 A process according to any of claims 23, 24, 26, 27 and 28, characterized in that said coupling in rigid and permanent manner said first external sheet and said second external sheet to said compact diamond-embossed sheet is done by projection resistance welding said compact diamond-embossed sheet between said first external sheet and said second external sheet.

32. A process according to any of claims 23, 24, 26, 27 and 28, characterized in that said coupling in rigid and permanent manner said first external sheet and said second external sheet to said compact diamond-embossed sheet is done by means of a fixing process selected from the group consisting of electric welding, spot welding, laser welding, hot pressure welding, diffusion bonding, soldering, press bonding, and brazing.

33. A process according to any of claims 23, 24, 26, 27, 28, 29 and 30, characterized in that said coupling in rigid and permanent manner said first external sheet and said second external sheet to said compact diamond-embossed sheet is done by means of a fixing process selected from the group consisting of adhesive bonding, hot pressure bonding and ultrasonic welding.

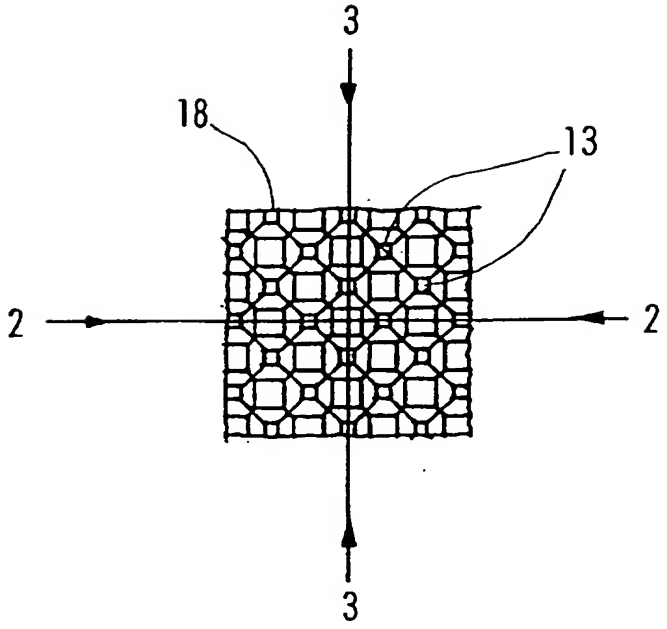

FIG. 1

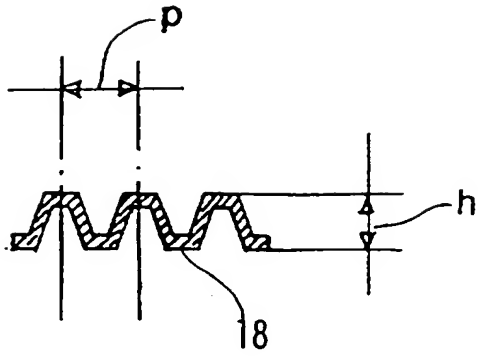

FIG. 2

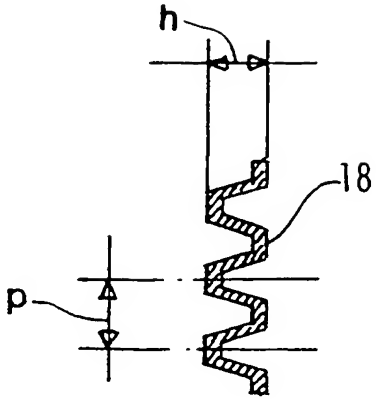

FIG. 3

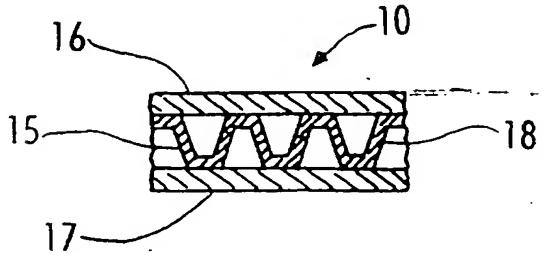

FIG. 4

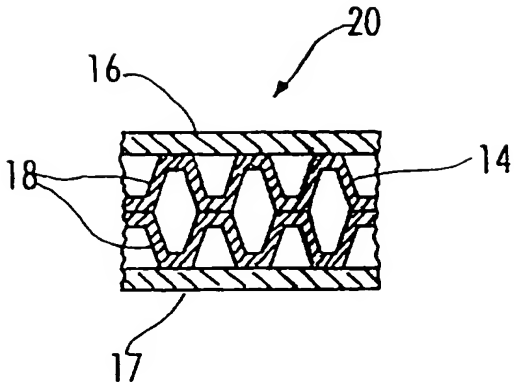

FIG. 5

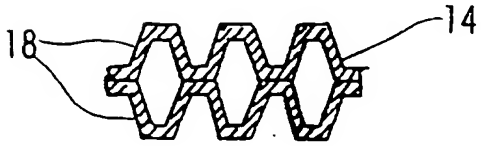

FIG. 6

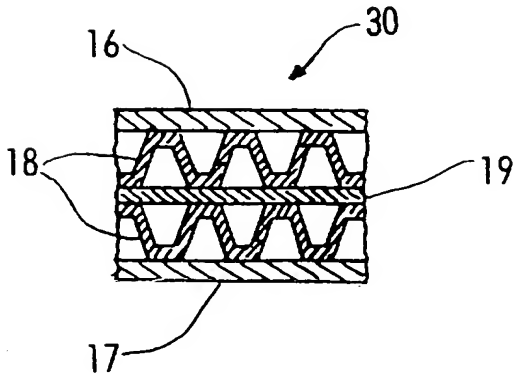

FIG. 7

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IT 97/00165

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B32B3/30 B21D13/02 B32B31/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B32B B21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 025 996 A (SAVEKER DAVID R) 31 May 1977	1,8,9, 12,13, 17,18, 23,32
Y	see column 3, line 43-59 - column 5, line 2-4; claims 1,2,6; figures 1,4 see column 5, line 19-37 - column 6, line 3-6; example	4-7,10, 14

X	US 5 156 327 A (TAKAHASHI AKIO ET AL) 20 October 1992	1,8,12, 13,17, 18,23, 32,33
Y	see column 2, line 12-15 - column 3, line 8-28; claims 1,3; figures 2B,,4 see column 4, line 8-10	3,9,10, 14,19, 29,30,33

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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1

Date of the actual completion of the international search	Date of mailing of the international search report
14 November 1997	24. 11. 97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Derz, T

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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	US 4 343 866 A (OSER NATHAN ET AL) 10 August 1982 see column 2, line 24-56 - column 4, line 44-64; claims 1,3-7; figure 8	1,2,4,6, 8,12,13, 17
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Y	GB 2 272 662 A (HADLEY IND PLC) 25 May 1994 see page 9, line 6-10; claims 1-5; figures 5,8	17,23, 27,28
Y	GB 2 279 596 A (SLOGGETT CYRIL) 11 January 1995 see page 4, line 20 - page 5, line 33; claims 1,6-8,11,17; figures 5-7	1,2
Y	DE 43 03 300 A (DIEDRICHS HELMUT W) 11 August 1994 see column 1, line 8-59; claims 1-7; figures 1-6	1,17,23

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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